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CENTRAL INTELLIGENCE AGENCY

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REPORT

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1. General Description

a. The seismic equipment, consisting of 24 channels, was suitable for performing reflection and small refraction measurements. The channels were for recording seismic waves. Each channel consisted of a seismometer, an amplifier with filter unit and a galvanometer. The seismometers were connected to their respective amplifiers with two-conductor cables. The amplified and filtered impulses from the seismometers were registered by the galvanometer of the oscillograph which was part of the main unit. The incoming impulses were registered in the oscillograph on photo-sensitive paper strips.

b. The apparatus contained a tuning-fork-controlled oscillator, a mixer for the partial suppression of interference waves, a telephone amplifier for the audio connection between the truck and the point of burst, and a main switchboard from which all the apparatus was easily controlled. In addition to the measuring devices the equipment contained a firing mechanism which made the explosion possible and was also used for registering the exact instant the explosion occurred. The equipment can be assembled on a field truck. The truck carries all the auxiliary equipment necessary for research in the field. It is equipped with items such as seismometer cable, supporting frames, photographic laboratory, storage batteries and B or high-tension batteries.

c. The amplifier units were arranged in two racks, each with 12 amplifiers, and a telephone amplifier and control mechanism. The switch board, oscillograph and signal generators were between the amplifier racks. Over these were the main switch and the fuses. Separate units of the rig were removable and easy to handle.

d. This seismic rig, with its assembled units, contained the most precise instruments and was built according to stringent specifications for reliability, workability and stability. These characteristics had to be preserved during transport over rough country, poor roads, and under extreme changes in humidity and temperature. The charts had to be capable of recording the vibrations to the nearest thousandth of a second with no more than a thousandth of a second of difference permitted between diagrams. Type Sz.M. 24-52 met

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these specifications. If used correctly it was guaranteed to give a high productivity and a high efficiency factor for research work.

2. Description of the Units in the Rig

a. The seismometer was an electrodynamic device with spring suspension and a characteristic frequency of 7.7± 0.2 cycles per second. The electromagnetic damping was 0.7 critical; the sensitivity of the instrument at the chosen impedance was 350 mV/Cel; the weight of the unit was 1.25 kilograms. The instrument was assembled in a large, watertight housing with a flexible cable of about 0.5 meter to which the terminals were attached. The outside measurements were 80 x 140 millimeters with non-removable cone.

b. All the amplifiers were provided with continuous sensitivity control and a six-step filter. The filter consisted of LC-elements with resonance frequencies of 27, 34, 43, 54 and 69 cycles per second in broad band transmission. In cases of equal voltage supply the individual resonance frequencies would give identical amplitudes. It also contained an AVC-Dynamic 54 dB. The time constant was 0.15 - 0.25 second AVC. Fully automatic amplitude control was achieved by the 20 MV signal in cases of maximum amplification of the uncontrolled input. Copper oxide rectifiers were used. The over-all amplification carried 100 dB without automatic amplitude control, with two 6S6 tubes and one 6AT6 tube. The critical damping of the seismometer was accomplished by the primary winding of the input transformer. The cable was connected to the amplifier by means of a so-called "cloan" connection. A cylindrical pin guaranteed unimpaired contact of the terminals. A multi-conductor cable led from the terminal to the registering apparatus and to the mixer. The amplifiers were interchangeable because they have identical characteristics.

c. The tuning fork oscillator and mixer were assembled on a common chassis. The tuning fork was made of "L-invar" material which has an unusually low thermal expansion coefficient. The 80 cycle frequency of the tuning fork maintained an accuracy of 0.1 percent with changes in temperature. The tuning fork oscillator, with two 6AK5 tubes and one 6AQ5 tube, worked on a 250V plate potential and produced an output of 110V at an energy level of 3 watts. The working principal of the oscillator was conventional. The amplifier was provided with three resistance-controlled stages whereby the transformer system of the tuning fork oscillator was connected to the input grid. The circuit from the secondary winding of the output transformer was connected to the corresponding circuit of the tuning fork oscillator. The incoming impulse set the tuning fork in motion; for test purposes the tuning fork could also be set in motion by means of a push button switch found on the front plate of the device. The fork maintained a frequency of 80 cycles and controlled the motion of the motor of the timer. The mixing was accomplished with resistances and could be switched off between the twelfth and thirteenth channels. The mixing ratio was 1:2.5. The mixer could be started manually or automatically. The impulses coming in from any of the 24 channels started the mixer with the help of an auxiliary electrical mechanism. The device contained one 6J6 tube.

d. The line amplifier, which stepped up the current from the point of blast, was connected to the microphone amplifier by means of a telephone switch. The audio line and explosion indicator line were handled simultaneously by the telephone amplifier. The potentiometer of the telephone amplifier was inside the chassis. This device contained two 6AK5 tubes and two St.6AQ5 tubes.

e. The testing oscillator (one ECC40 tube) delivered the filtering resonance frequencies (24, 34, 43, 54, 68 cycles); the output voltage was controllable from 0 to 100 millivolts. The controls were on the front panel with the connecting terminals in the rear, as were the amplifiers.

f. Recording apparatus

1) Sensitivity of the galvanometer: 3×10^{-6} A/m/mm in cases of critical damping; damping factor: 0.7 ± 0.1 critical; characteristic frequency: 130 ± 3 cycles. Parts were easily exchangeable. Damping and sensitivity were adjustable through resistances. The parasitic oscillation of the galvanometer in the case of a 6 cm direct current impulse would be, at the most, 0.6 millimeters.

2) The galvanometer unit was provided with a heating element which made it possible to regulate the temperature in periods of cold weather to prevent fogging of the mirrors and lenses of the galvanometer and shrinking of the torsion fibers. The lighting of the galvanometer was accomplished by means of three St. 12V, 15W auto lamps. The galvanometer was attached to the chassis beneath the time marking motors.

3) A 40 meter roll of registration paper, 200 millimeters wide, could be stored in the oscillograph. A pointer on the magazine indicated the amount of paper in the supply. The motor used to operate the paper rolls was located inside the oscillograph and operated on a 12V current. The speed of the paper was adjustable between 25 and 50 cm per second by means of a switch. The variability was maintained at less than 15 percent.

4) The time marker was in the middle of the oscillograph on the upper part of the frame. It operated according to the principle of the "Lacourt Wheel." A self starting synchronous motor turned the slotted drum so that thin but intense lines (100 per second) were drawn vertical to the paper strip. The 0.01, 0.05 and 0.1 second marks were of different intensity. In the middle of the slotted drum was a 12V, 10W lamp. The number of revolutions of the time marker was independent of the voltage.

5) The optical system was simple. The unit lamp illuminated the galvanometer directly and the light beam from the mirror of the galvanometer focused through a lens system onto the light-sensitive paper. The parallax in this system was no greater than 1 millimeter. The light paths were well controlled during the whole operation by the two-mirror system behind the paper. The switch for the feed voltage and a voltmeter, with which the alternating current voltage of the time-marking apparatus was checked, were on the switchboard of the oscillograph. The power supply was provided through plugs arranged on the back of the switch board.

g. The main switchboard contained the switches for the individual units and indicator lights for each of the circuits. All voltages were controlled through one device. The oscillograph, the test-oscillator and the tuning fork oscillator were controlled through special switches installed on this board. The siren button, with which the observers could be signaled, was also located here.

h. The control device, through the use of the proper control switches, made the following measurements possible:

1) Cable resistance

2) Surge measurement of the oscillating part of the seismometer with direct current in both directions; the measurement was done with a milliamperemeter.

3) Amplifier testing with the test-oscillator

4) Amplifier testing with a seismometer

5) Insulation testing between the cable and the earth

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Each of the seismometers was controlled in this way and their coil movement could be checked. The voltage of the built-in oscillators, which produced the resonance frequency of the filter units, could be switched on to any of the amplifiers. The control switches, which were also removable, were easily operated; they had double contacts of a good grade of brass. All control testing could be done in the truck without the operator leaving his seat. Telescope springs protected the instruments from the poor traveling conditions of the areas in which they had to be used.

2. The firing apparatus could detonate ten parallel connected special charges. Less than a millisecond elapsed between the throwing of the switch and the explosion. Two tenths of a second before the time of the explosion the registering apparatus was automatically switched on through the firing device. The firing device was also equipped to test the detonators.

3. The instrument cases, photographic laboratory, cabinets and shelves for the batteries and chemicals were located inside the field truck. Liquids used during operations were passed directly out into the open. The main seismic gear was carried in a trailer along with the portable seismic gear and all of the cable. The portable equipment was used when it was impossible to operate the motorized equipment because of terrain or woods.

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